DISEASES IN PACIFIC NORTHWEST FOREST PLANTATIONS

BY

DAVID W. JOHNSON,

PLANT PATHOLOGIST

U.S. FOREST SERVICE

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EVALUATION OF DISEASES IN NATIONAL FOREST PLANTATIONS IN THE PACIFIC NORTHWEST

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ACKNOWLEDGMENT

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John H. Thompson, former Plant Pathologist, U.S. Forest Service, Portland, Oregon, now Field Office Supervisor, U.S. Forest Service, Asheville, North Carolina; Donald P. Graham, former Supervisory Plant Pathologist, U.S. Forest Service, Portland, Oregon, now Director Insect and Disease Control, U.S. Forest Service, Albuquerque, New Mexico; John T. Wortendyke, former Plant Pathologist, U.S. Forest Service, Portland, Oregon, now Forester, U.S. Forest Service, Portland, Oregon; and Hubert H. Bynum, former Plant Pathologist, U.S. Forest Service, Portland, Oregon, now deceased.

INTRODUCTION

The potential for diseases to cause damage in forest tree plantings is widely recognized by forest pathologists. Certain characteristics of many artificial plantings, such as purity of composition, regularity of spacing, evenness of age and poor adaptability to the site, make them more susceptible to diseases than naturally regenerated stands. In spite of the hazards, artifical regeneration of harvested areas plays a vital role in intensive forest management. It is anticipated that over 100,000 acres of National Forest System land will be planted in Oregon and Washington in 1975. Better information on the occurrence, identity, distribution and severity of plantation disease problems in the Pacific Northwest is needed by all forest land managers.

An extensive survey of National Forest plantations in Oregon and Washington was undertaken in 1970 and 1971 to evaluate disease problems and to provide insight into future problems. A systematic survey was conducted in southwestern Oregon in 1969 in a number of randomly selected plantations (age 5 to 12 years old).

The data indicated that disease was of minor importance, and that severely diseased plantations were not likely to be sampled as a result of using a relatively small random sample. In subsequent years, only plantations where disease was known or suspected to be present were examined in this survey.

METHODS

Plantation selection: Each National Forest in Oregon and Washington was requested to submit a list of plantations from 1 to 30 years old in which diseases were known or suspected to have an impact. This included planting failures and plantations where stocking or tree vigor was threatened by either infectious or non-infectious diseases. Plantations where damage resulted from other than disease situations were omitted from the list. A total of 322 were selected and subsequently formed the basic sample for the survey. Additions and deletions to the list were made after consultation with reforestation personnel on each District. A list of Forests and Ranger Districts included in the survey is presented in Table 1.

Survey procedure and data collection: A systematic survey was made of each selected plantation. Surveyors designated an approximate center point in each plantation from which pairs of 1 by 1/8 chain transects were run in each of the four cardinal directions (Figure 1). In plantations of less than 20 acres, one of each pair of transects started 1 chain from the center. In plantations of 20 acres or more, this starting point was 3 chains from the center. The other member of each transect pair started 1/2 chain in from the plantation boundary and extended toward the center. Data were recorded for all trees over 6 inches high (Figure 2).

A reconnaissance survey was also conducted for each plantation. As the crew walked through the unit they noted disease problems not encountered in the systematic survey. Disease identity, distribution, severity and contributing factors were recorded. Supplemental information on each plantation was obtained from reforestation records or from consultation with District personnel.

Diseases not specifically identified were recorded by general categories: root disease, stem rust, stem canker, foliage disease, dwarf mistletoe, non-infectious disease and other damage (Figure 2). Samples were collected for laboratory examination and identification.

Data analysis: Data were compiled and analyzed to determine the following:

1. Relative importance of general disease categories and specific disease problems on a Regional basis.

2. Regional distribution and severity of diseases.

3. Relationships between disease incidence and physical characteristics of the plantation site including

elevation, aspect, age of the plantation, stand history and species composition.

RESULTS

Distribution of surveyed plantations in the Region: A total of 361 plantations, covering almost 14,000 acres was examined. Data from the survey conducted in 1969 is included. All but 30 of the plantations were systematically surveyed. A reconnaissance survey was conducted on these plantations. A map showing the distribution of the plantations is presented in Figure 3. Ninety-six percent of the plantations were located west of the Cascade Range, thus the data represent disease problems primarily encountered in that part of Oregon and Washington.

Physical characteristics of surveyed plantations: The physical characteristics of the plantations are presented in Table 2. The majority of the units were 20 to 39 acres in size and ranged in elevation between 2,100 to 4,000 feet.

Historical data on surveyed plantations: The historical data on the plantations are presented in Table 3. The majority of the sites were burned prior to planting. Douglas-fir and ponderosa pine were planted in over 83 percent of the units. Most of the units were 5 to 9 years old at the time of the survey.

Major causes of damage in plantations: A list of the major causes of damage to plantations is presented in Table 4. Non-infectious diseases including mechanical, weather, animal and insect damage were noted in 85 percent of the plantations. The most common infectious diseases were Armillaria root rot and white pine blister rust. Foliage diseases were less frequently encountered than either root or stem diseases. Maps showing the distribution of the most important infectious diseases are presented in Figures 4 through 11. The occurrence of specific disease problems on each Forest is presented in Table 5.

Influence of elevation on occurrence of diseases: Data were sorted by plantation elevation to determine if elevation had any influence on the occurrence of specific diseases. The needle cast fungus, *Lophodermella morbida*, was restricted to ponderosa pine plantations at elevations ranging from 3,100 to 4,000 feet (Table 6). No other disease-elevation relationships were noted.

Influence of aspect on occurrence of diseases: Data were sorted by aspect of the plantations to determine if any relationships existed with specific disease problems. None were noted (Table 7).

Influence of plantation age on occurrence of diseases: Data were sorted by plantation age to determine if any relationship existed with disease occurrence. Most root diseases were more frequent in the older plantations (Table 8).

DISCUSSION

This survey has provided additional information on the occurrence and distribution of major disease problems in plantations in the Pacific Northwest Region. The most important problems are caused by weather and root diseases. To prevent weather-related injuries, the land manager should carefully choose tree species and seed sources adapted to the site. An excellent example of the type of problem that may occur when a tree species is planted off-site is the occurrence of *Lophodermella morbida* on ponderosa pines. This disease is not found in "on-site" trees established in very close proximity to diseased "off-site" plantings.

The major problem confronting land managers is root diseases. Losses are expected to increase in the future.

Of the major root diseases in the Region, *Poria weirii* (*Phellinus weirii*) root rot is generally recognized as the greatest danger to sustained production. Persistence and gradual spread of the fungus from one rotation of susceptible tree species to the next is a threat to succeeding stands and results in reduced site productivity.

Silvicultural practices such as the planting of less susceptible tree species and the planting of mixed tree species have the most promise for control of the disease.

Although Armillaria root rot is the most common and widely distributed root disease in the Region, the damage caused by this fungus is not expected to be as great as that caused by *Poria weirii*. *Armillaria mellea* is primarily a "pathogen of opportunity" and attacks weakened, less vigorous trees. Good planting practices and maintenance of stand vigor by silviculture will reduce the hazard of most stands to Armillaria root rot.

Verticicladiella root rot or black stain root disease has recently been identified in the Region, but its potential for damage has not been assessed. This survey has extended the known geographic range of the disease in the Pacific Northwest. Although black stain root disease was observed several times during this survey, it was seldom responsible for killing more than a small number of trees in an infection center.

Stem diseases were the second most important group of infectious diseases encountered during the survey. White pine blister rust was the most frequently occurring stem rust disease. Losses in the future are expected to be reduced substantially as rust-resistant selections of western white pine and sugar pine become available. The U.S. Forest Service and Bureau of Land Management are cooperating in the selection of rust-resistant pines in the Pacific Northwest.

Losses to other stem diseases were relatively unimportant. Discrimination against infected trees during scheduled timber stand improvement operations is the only recognized method of reducing losses to the other stem diseases.

Foliage diseases were frequently encountered during the survey; however, except for *Lophodermella morbida*, damage was slight. Control of this group of diseases is best accomplished through the selection of trees adapted to the site and discrimination against diseased individuals.

The major effort toward control of disease in plantations is through prevention. The proper selection of species and seed sources adapted to each planting site is essential to disease control. Pure stands are a greater risk than stands of mixed species. Spacing is important in maintaining the vigor of the stand. The selection and breeding of disease-resistant trees, particularly western white pine and sugar pine, is receiving more emphasis in the Pacific Northwest. Knowledge of individual disease problems is essential to the formulation of the best management practices for our plantations. This survey has increased our awareness of the disease problems confronting land managers; we now must meet the challenge and improve our forest practices accordingly.

Table 1.--Forests and Ranger Districts included in plantation disease survey 1969-1971

Forest	Ranger District
Deschutes	Bend
Fremont	Silver Lake
Gifford Pinchot	St. Helens Mt. Adams Packwood Randle Wind River
Mt. Baker	Baker River Glacier
Mt. Hood	Barlow Bear Springs Clackamas Columbia Gorge Estacada Hood River
Olympic	Quilcene Quinault
Rogue River	Applegate Ashland Butte Falls Prospect
Siskiyou	Chetco Galice Gold Beach Illinois Valley Powers
Siuslaw	Mapleton Alsea Waldport
Snoqualmie	White River

Table 1 cont.

Forest	Ranger District
Umpqua	Cottage Grove Tiller Diamond Lake Glide Steamboat
Wallowa-Whitman	Baker
Wenatchee	Cle Elum Ellensburg Lake Wenatchee
Willamette	Blue River Sweet Home Lowell Oakridge Rigdon

Table 2.--Physical characteristics of plantations examined during 1969-1971 survey

	No. Plantations	Percent of Total Plantations
Plantation Size (acres)		
1-19	34	9.4
20-39	142	39.3
40-59	98	27.1
60-79	35	9.7
80-99	23	6.4
100+	15	4.3
Not recorded	14	3.9
Elevation (range in feet)		
0-1000	30	8.3
1100-2000	34	9.4
2100-3000	96	26.6
3100-4000	102	28.3
4100-5000	54	15.0
5100-6000	27	7.5
6100-7000	2	0.6
7100-8000	1	0.3
8100-9000	2	0.6
Not recorded	13	3.6
Aspect		
Flat	52	14.4
North	86	23.8
East	63	17.4
South	66	18.3
West	73	20.2
Not recorded	21	5.8
Percent Slope		
Flat	52	14.4
1-25	117	32.4
26-65	150	41.6
66+	21	5.8
Not recorded	21	5.8

Table 3.--Historical data on plantations examined during 1969-1971 survey

	No. Plantations	Percent of Total Plantations
Site preparation		
Burned	334	92.5
Other	27	7.5
First species planted		
Douglas-fir	212	58.7
True fir	9	2.5
Ponderosa pine & Jeffrey pine	89	24.7
Western white pine & Sugar pine	20	5.5
Mixed species	22	6.1
Not recorded	9	2.5
Year planted		
1945-1949	4	1.1
1950-1954	27	7.5
1955-1959	94	26.0
1960-1964	203	56.2
1965-1969	18	5.0
Not recorded	15	4.2

Table 4.--Major causes of damage to plantations in the Pacific Northwest

Damaging Agent	No. Plantations Affected	Percent Of Total Plantations
Root Diseases	136	37.7
Armillaria mellea	107	29.6
Poria weirii	49	13.6
Fomes annosus	12	3.3
Verticicladiella wagenerii	11	3.0
Other	6	1.7
Stem Diseases	129	35.7
Cronartium ribicola	99	27.4
Endocronartium harknessii	19	5.3
Cronartium stalactiforme	2	0.6
Other	36	9.9
Foliage Diseases	103	28.5
Rhabdocline pseudotsugae	9	2.5
Lophodermella morbida	9	2.5
Snow molds	22	6.1
Other	66	18.3
Non-infectious Diseases	307	85.0
Mechanical-Weather	221	61.2
Animals	219	60.7
Insects	190	52.6
Unknown	9	2.5

Table 5.--List of National Forests, numbers of plantations examined and major damaging agents encountered during 1969-1971 survey*

Forest	No. Plantations Examined	Root Diseases					Stem Diseases				Foliage Diseases				Non-infectious Diseases			
		A. mellea	*P. weirii*	*F. annosus*	*V. wageneri*	Other	*C. ribicola*	*E. harknessii*	*C. stalactiforme*	Other	*R. pseudotsugae*	*L. morbida*	Snowmolds	Other	Mechanical-Weather	Animals	Insects	Unknown
Deschutes	4	x								x			x	x	x	x	x	
Fremont	2	x														x	x	x
Gifford Pinchot	16	x	x	x	x		x			x			x	x	x	x	x	
Mt. Baker	11	x	x	x	x			x		x					x	x		
Mt. Hood	15	x	x	x		x				x	x		x	x	x	x	x	
Olympic	1	x	x	x	x												x	
Rogue River	104	x	x	x		x	x	x		x			x	x	x	x	x	
Siskiyou	75					x	x	x	x				x	x	x	x	x	x
Siuslaw	18	x	x		x					x	x			x	x	x	x	x
Snoqualmie	3	x	x	x	x		x			x					x	x	x	
Umpqua	85	x	x		x		x	x	x	x	x	x			x	x	x	x
Wallowa-Whitman	4			x	x			x		x				x	x	x	x	
Wenatchee	10	x	x				x	x		x			x	x	x	x	x	x
Willamette	17	x	x	x	x		x					x	x	x	x	x	x	

*Includes systematic and reconnaissance surveyed plantations.

Table 6.--Occurrence of diseases by elevation of plantations

Elevation (Range in Feet)	No. Plantations Examined	Numbers of plantations affected																
		Root Diseases					Stem Diseases				Foliage Diseases				Non-infectious Diseases			
		A. mellea	*P. weirii*	*F. annosus*	*V. wageneri*	Other	*C. ribicola*	*E. harknessii*	*C. stalactiforme*	Other	*R. pseudotsugae*	*L. morbida*	Snowmolds	Other	Mechanical-Weather	Animals	Insects	Unknown
0-1000	30	2	17	1	2					3	3		1	6	13	16	10	
1100-2000	34	9	7		2		2	2	1	2	1		2	5	18	24	22	
2100-3000	96	18	11	4	7		24	3	1	12	2		3	16	70	68	55	4
3100-4000	102	39	8	3			46	9		10	1	9	8	20	65	62	70	2
4100-5000	54	21	2	2			16	1		4			4	12	33	36	19	
5100-6000	27	11	2				9	2		4			3	5	19	11		
6100-7000	2									1			1	1	2	1	12	3
7100-8000	1						1							1	1	1	1	
8100-9000	2	1	2								2						1	
Not recorded	13	6		2			1	2										
Totals	361	107	49	12	11		99	19	2	36	9	9	22	66	221	219	190	9

Table 7.--Occurrence of diseases by aspect of plantations

Aspect	No. Plantations Examined	Numbers of plantations affected																
		Root Diseases					Stem Diseases				Foliage Diseases				Non-infectious Diseases			
		A. mellea	*P. weirii*	*F. annosus*	*V. wageneri*	Other	*C. ribicola*	*E. harknessii*	*C. stalactiforme*	Other	*R. pseudotsugae*	*L. morbida*	Snowmolds	Other	Mechanical-Weather	Animals	Insects	Unknown
Flat	52	27	3	2	2	1	32	5	1	7			2	16	38	34	26	1
North	86	19	10	4	1	2	23	4	1	8	3	2	6	15	54	52	47	4
East	63	13	10	3	2		13	2		4	1	3	3	17	34	34	34	2
South	66	24	15		3		15	3		7	2		8	8	45	41	36	1
West	73	17	9	1	2	3	14	3		7	3	4	2	7	43	52	39	1
Not recorded	21	6	2	2	1		2	2		3			1	3	7	6	8	
Totals	361	107	49	12	11	6	99	19	2	36	9	9	22	66	221	219	190	9

Table 8.--Occurrence of diseases by year of planting (age of planting)

Year of Planting	No. Plantations Examined	Root Diseases					Stem Diseases				Foliage Diseases				Non-infectious Diseases			
		Numbers of plantations affected																
(Age of planting) from beginning of survey		*A. mellea*	*P. weirii*	*F. annosus*	*V. wageneri*	Other	*C. ribicola*	*E. harknessii*	*C. stalactiforme*	Other	*R. pseudotsugae*	*L. morbida*	Snowmolds	Other	Mechanical-Weather	Animals	Insects	Unknown
1945-1949 (20-24)	4	3	1	1	1	1		1		1		1		3	3	2	2	
1950-1954 (15-19)	27	23	11	4			14	6	1	7	1	2	6	11	24	18	24	
1955-1959 (10-14)	94	29	20	1	2	2	32	8		9	5	6	8	20	50	52	42	3
1960-1964 (5-9)	2203	40	13	3	5	3	41	2	1	12	3		4	21	116	135	111	1
1965-1969 (0-4)	18	4					11			4			3	8	16	10	7	5
Not recorded	15	8	4	3	3		1	2		3			1	3	2	2	4	
Totals	361	107	49	12	11	6	99	19	2	36	9	9	22	66	221	219	190	9

Figure 1.--Diagram of transect layout for systematic plantation survey

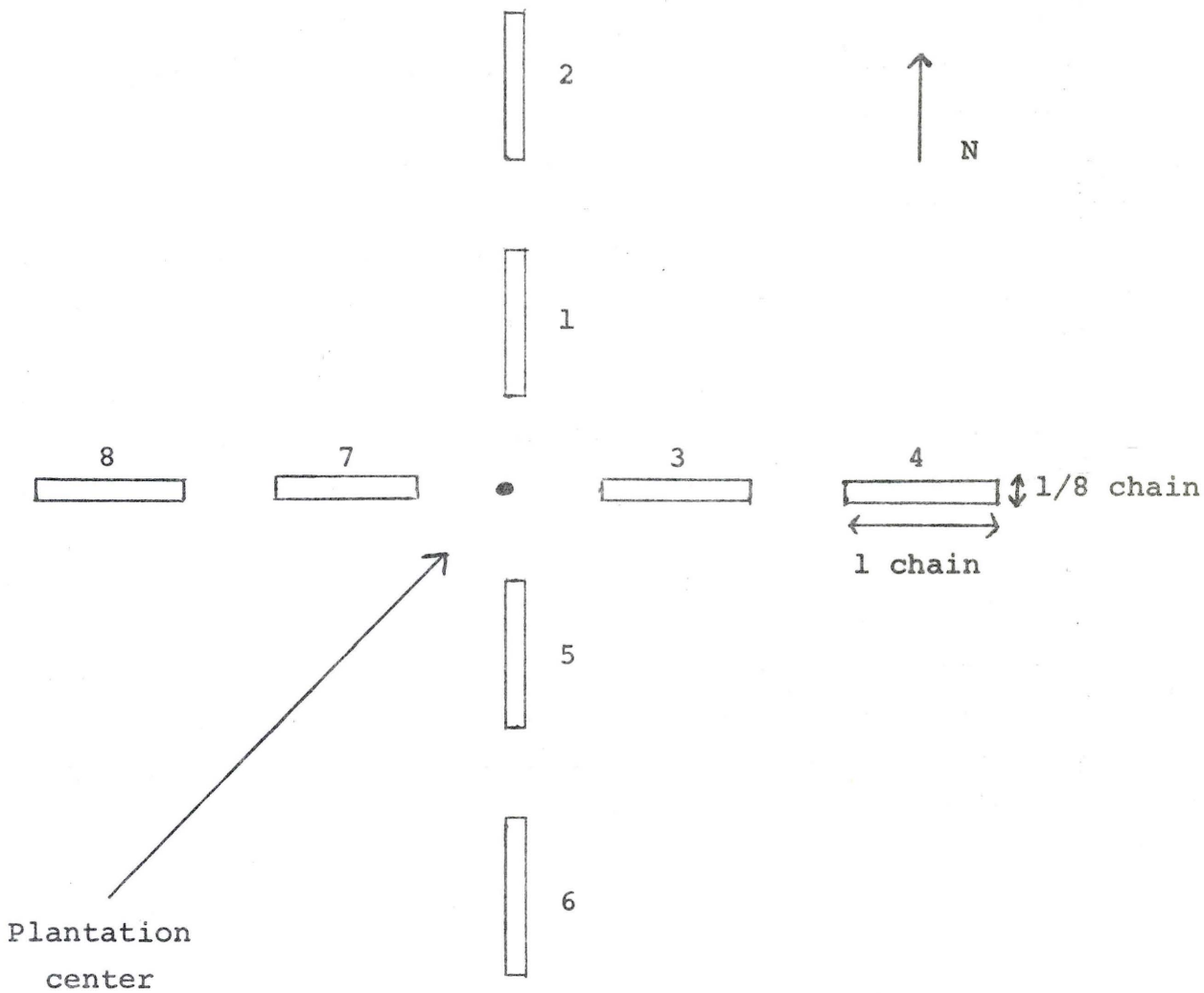

Figure 2.-PLANTATION DISEASE SURVEY FORM

1. Forest	xx____	7. Aspect	x____	Date:	
2. District	xx____	8. Slope	x____	Crew:	
3. Plantation Size	xx____	9. Overstory Composition	x____	Plantation Identification:	
4. Year Planted	xx____	10. Stand History	x____		
5. Species Planted	xxx____	11. Site Preparation	x____		
6. Elevation	xx____	12. Transect No.	x____	Seed Source:	

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Tree Number	Species	Height	Growth Last Year	Growth 2 Years Ago	Growth 3 Years Ago	Condition	Root Disease	Stem Rust	Stem Canker	Foliage Disease	Dwarf Mistletoe	Noninfect. Disease	Other Damage	Severity	Remarks
xxx	xxx	xx	xx	xx	xx	x	xx	xx	xx	xx	xx	xx	x	x	

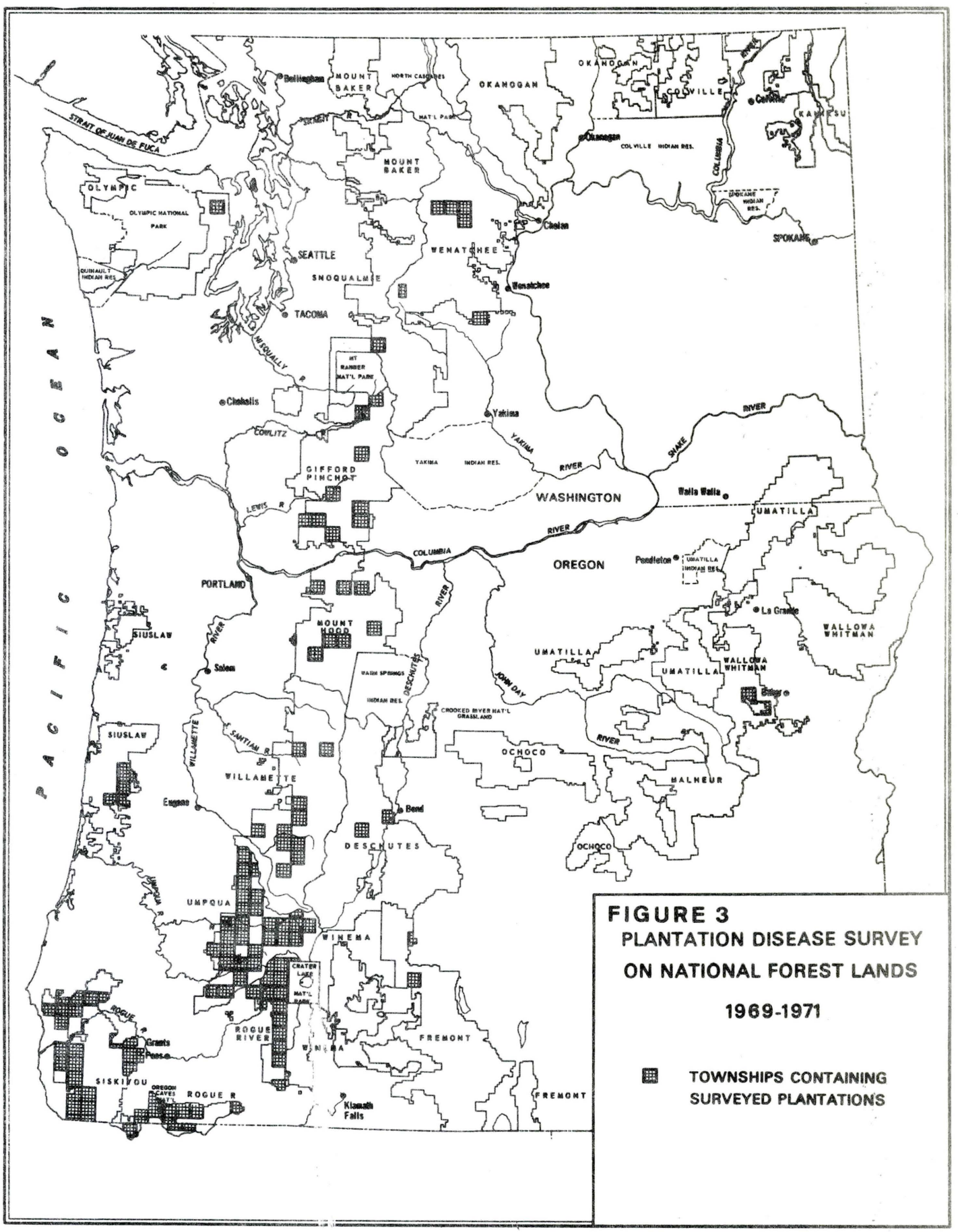

FIGURE 3
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

▩ TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

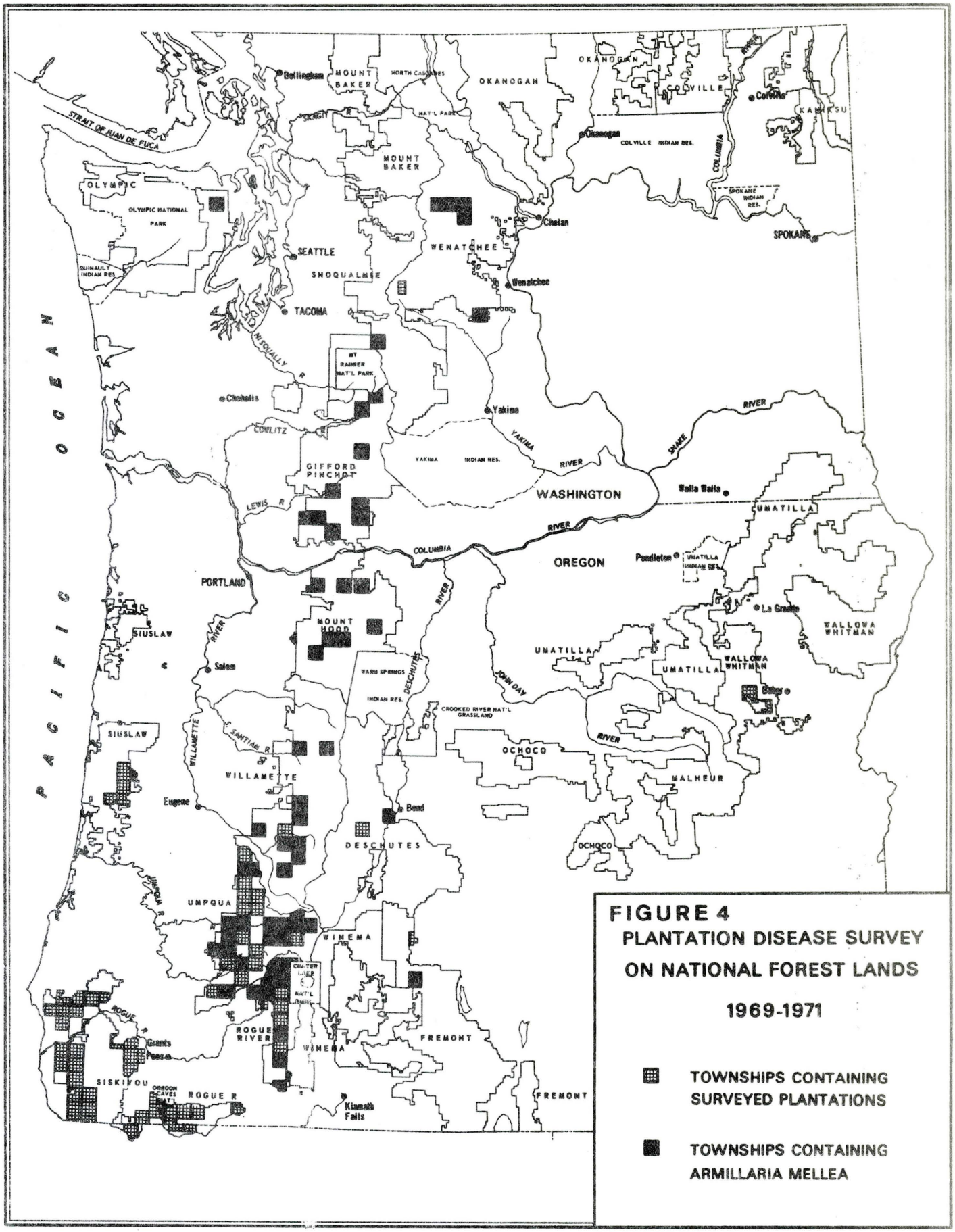

FIGURE 4
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

▦ TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

■ TOWNSHIPS CONTAINING ARMILLARIA MELLEA

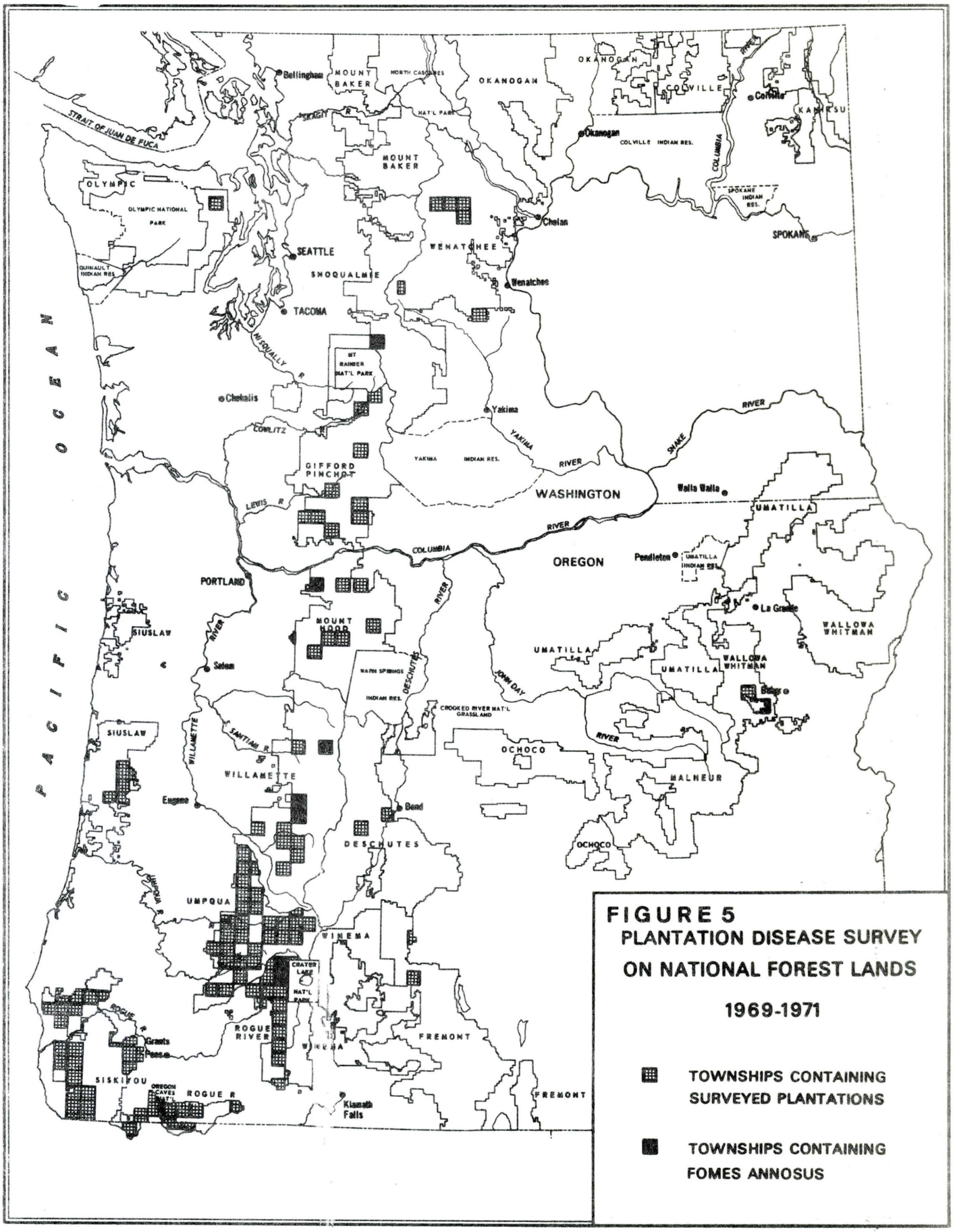

FIGURE 5
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

TOWNSHIPS CONTAINING FOMES ANNOSUS

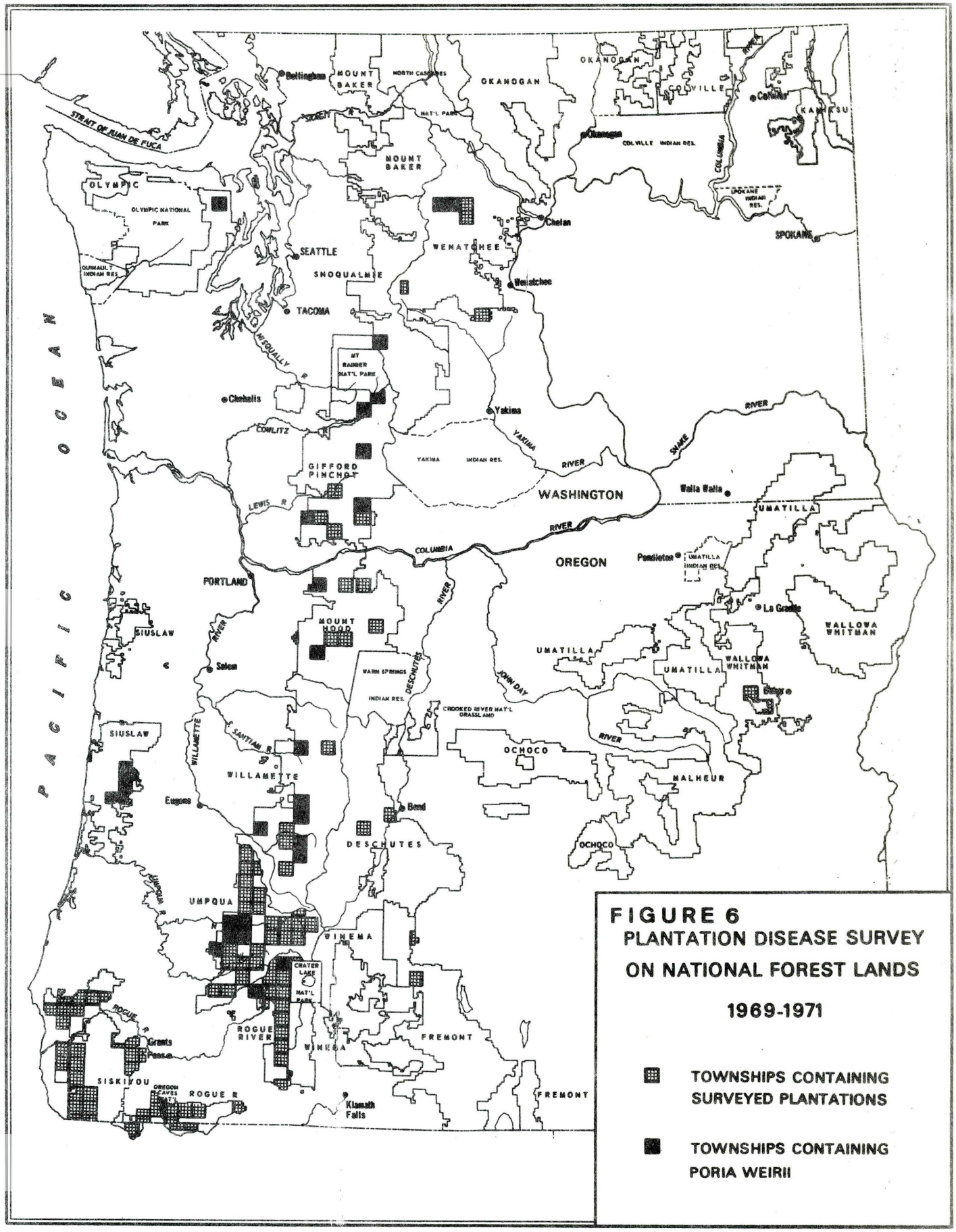

FIGURE 6
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

▦ TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

■ TOWNSHIPS CONTAINING PORIA WEIRII

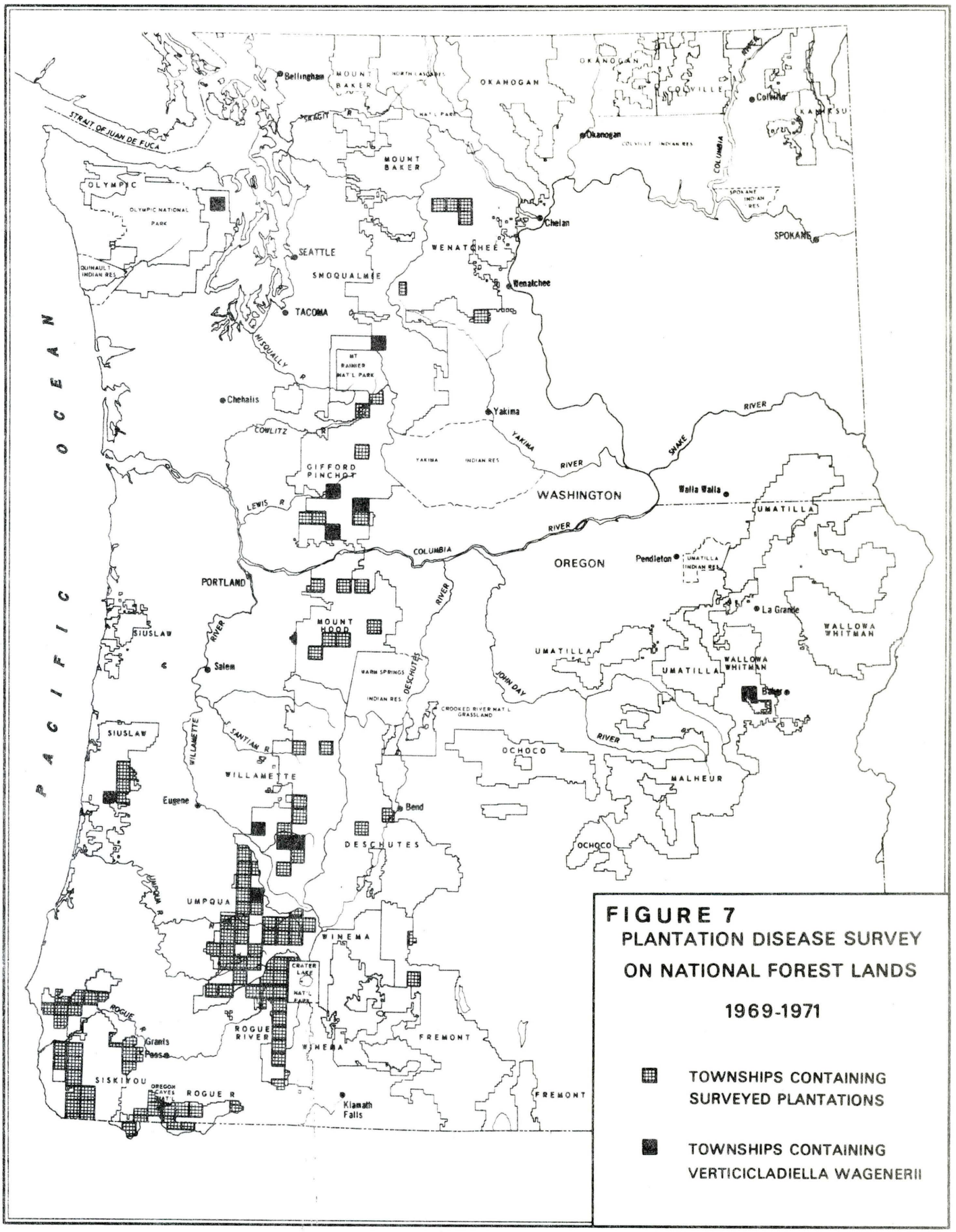

FIGURE 7
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

▦ TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

■ TOWNSHIPS CONTAINING VERTICICLADIELLA WAGENERII

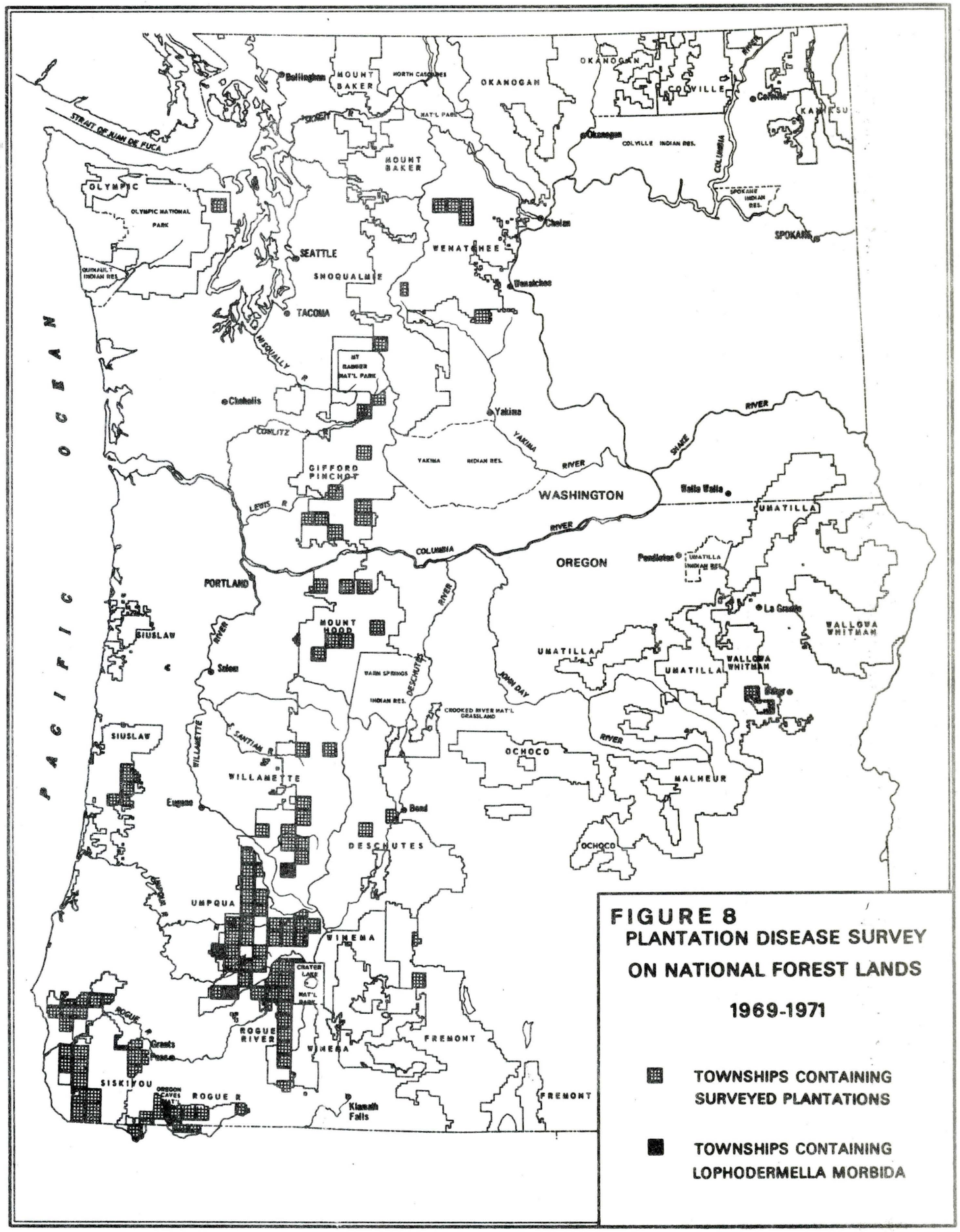

FIGURE 8
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

▩ TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

■ TOWNSHIPS CONTAINING LOPHODERMELLA MORBIDA

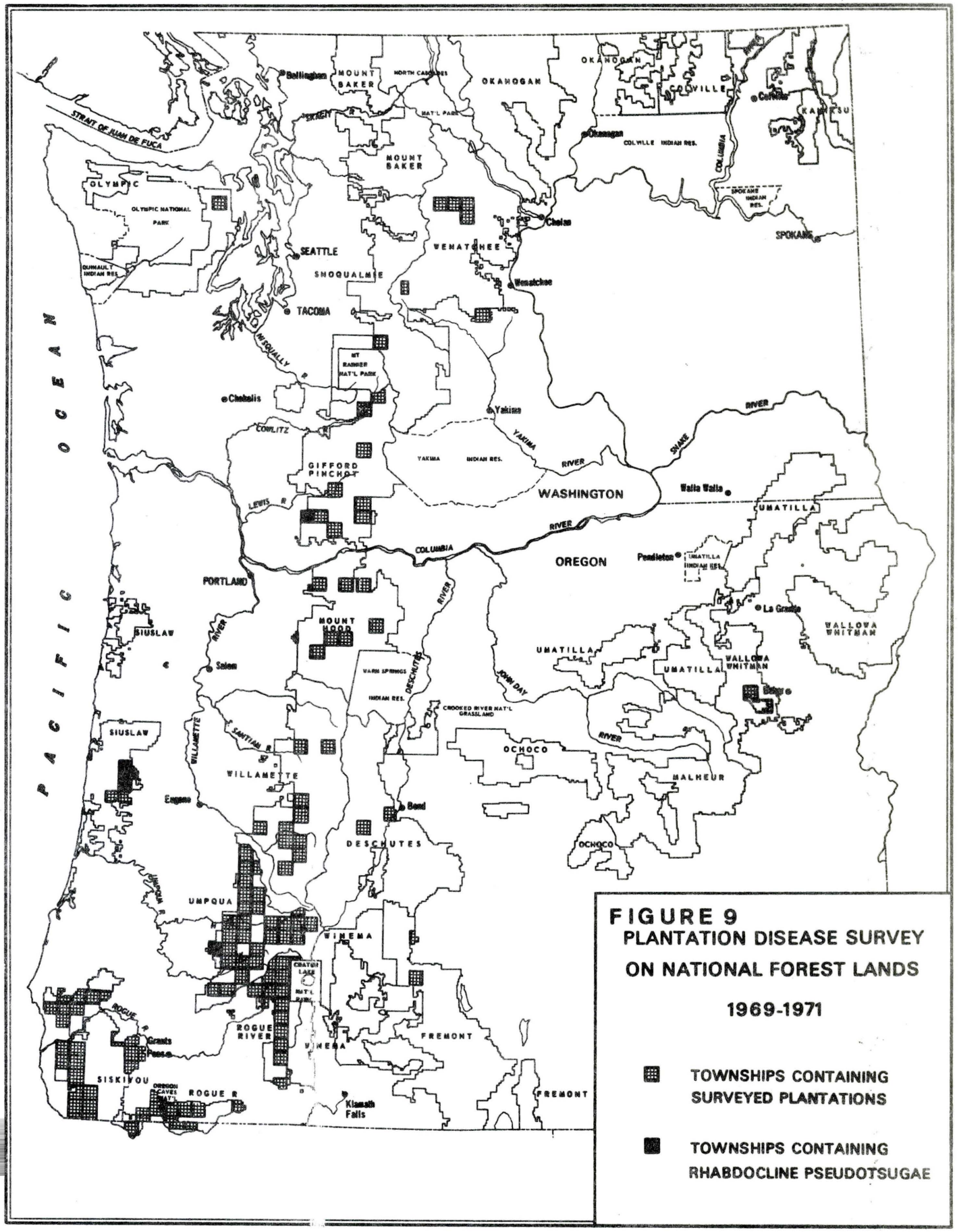

FIGURE 9
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

TOWNSHIPS CONTAINING RHABDOCLINE PSEUDOTSUGAE

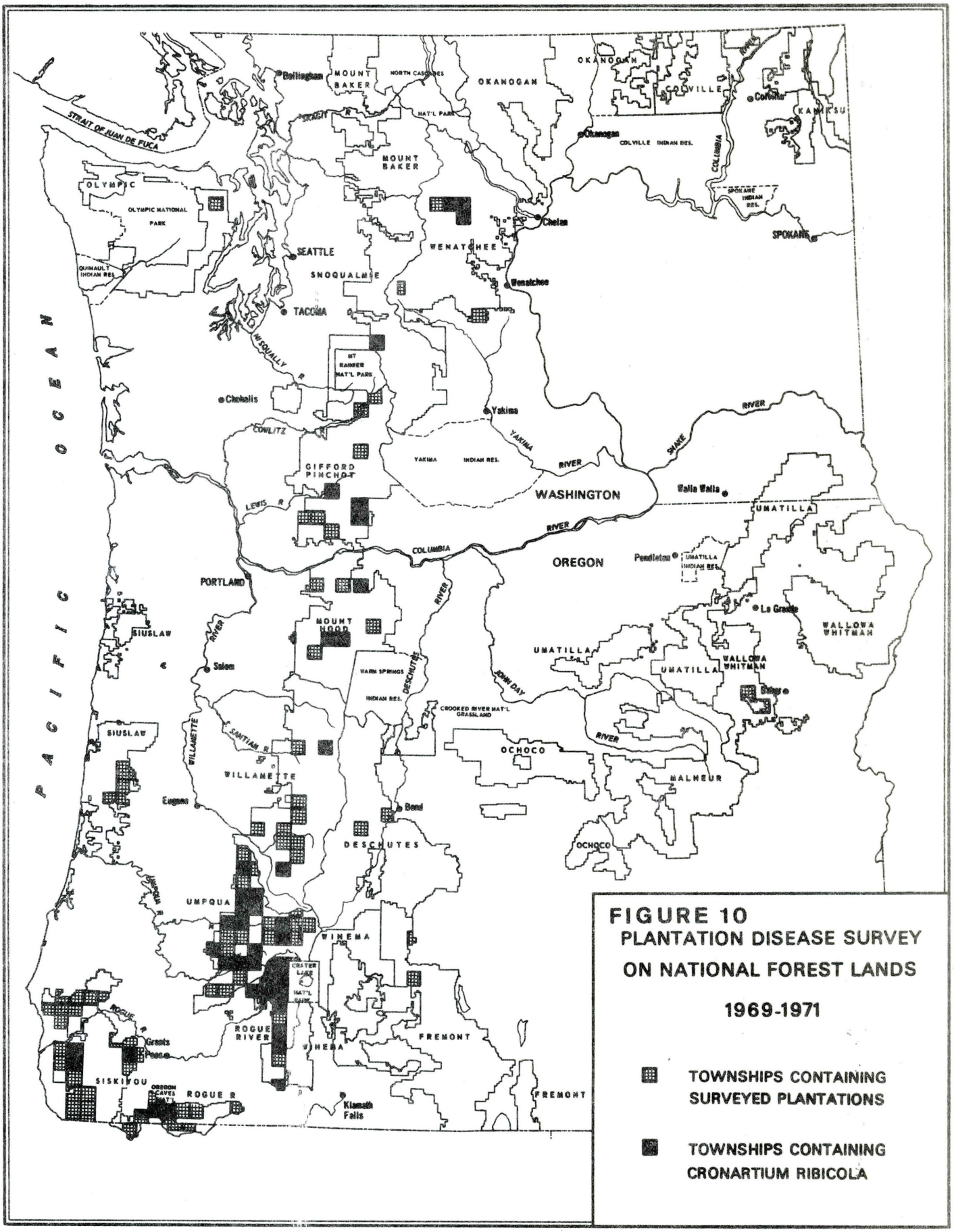

FIGURE 10
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

- TOWNSHIPS CONTAINING SURVEYED PLANTATIONS
- TOWNSHIPS CONTAINING CRONARTIUM RIBICOLA

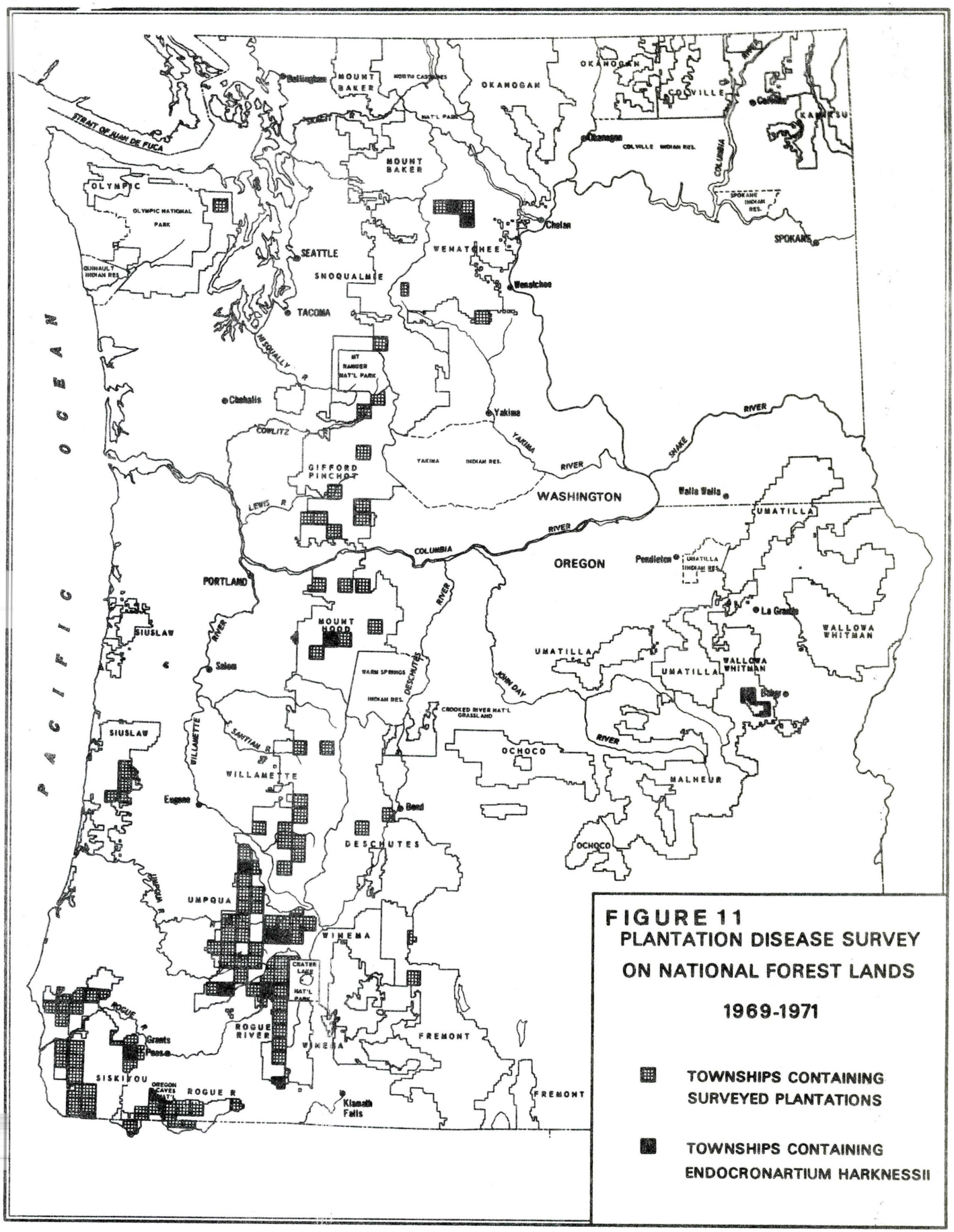

FIGURE 11
PLANTATION DISEASE SURVEY ON NATIONAL FOREST LANDS
1969-1971

TOWNSHIPS CONTAINING SURVEYED PLANTATIONS

TOWNSHIPS CONTAINING ENDOCRONARTIUM HARKNESSII